

## CHAPTER CONTENTS

## Quick Lab

Escape from  
a Planetoid 229

6.1 Energy for Lift-Off 230

6.2 Energy of  
Orbiting Satellites 236

6.3 Energy and  
Momentum in Space 250

Investigation 6-A  
Superball™ Boost 257

PREREQUISITE  
CONCEPTS AND SKILLS

- Newton's law of universal gravitation
- Potential energy
- Centripetal force
- Kinetic energy



**M**aster jugglers can keep as many as eight plates or seven flaming torches airborne and under perfect control at the same time. Amazing muscle and hand-eye co-ordination enables the launching of each object with precisely the right kinetic energy. Opposing Earth's gravitational attraction, this energy allows the object to free fall for a precise interval, returning to the height of the juggler's hand at just the right time and location to be caught and passed to the other hand for another toss.

Launching a missile or an Earth satellite is much like juggling. Work done against gravitational forces partially overcomes Earth's attraction and allows the object to follow a planned trajectory or to be inserted into a previously defined orbit. With even more initial energy, a space probe can eventually escape from Earth's orbit — or even from the solar system entirely. Successful launches depend on calculating, modelling, and simulating the energies needed to attain orbits or trajectories with specific shapes and sizes.

Your investigations of impulse, momentum, work, and energy have given you many of the mathematical tools needed to analyze energy and motion in space. In this chapter, you will refine your concept of gravitational potential energy, find out how much work must be done to boost an object away from a planet's surface, and investigate the energy of satellites in orbit.